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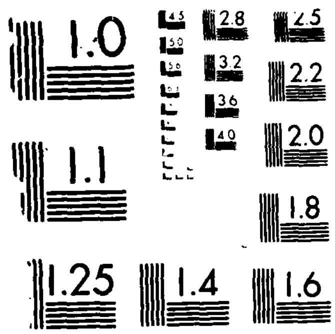

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USAFOEHL REPORT

87-038EQ0121CSC

FOR HEALTH & ENVIRONMENT

WASTEWATER TREATMENT PLANT EVALUATION, MCGUIRE AFB NJ

AD-A180 202

FRANCIS E. SLAVICH, 1LT, USAF, BSC

March 1987

Final Report

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USAF Occupational and Environmental Health Laboratory
Aerospace Medical Division (AFSC)
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JOHN J. COUGHLIN, Colonel, USAF, BSC
Commander

Prepared By:

FRANCIS. E. SLAVICH, 1Lt, USAF, BSC
Consultant, Water Quality Engineer

Reviewed By:

Marlin L. Sweigart

MARLIN L. SWEIGART, Lt Col, USAF, BSC
Chief, Environmental Quality Branch

Darryl T. Markland

DARRYL T. MARKLAND, Col, USAF, BSC
Chief, Consultant Services Division

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The USAFOEHL conducted a survey evaluating the wastewater treatment facility at McGuire AFB, New Jersey. The scope of the survey included the evaluation of: (1) individual treatment plant unit processes, (2) influent and effluent sewage quality, (3) treatment plant flow rates, and (4) operational and maintenance practices.

Results of the survey showed that the plant was not meeting the 7-day NJPDES effluent standards for Total Phenols, Total Suspended Solids (TSS), and removal efficiency for TSS. Overall, the unit processes of the plant are performing adequately; notwithstanding correctable operation and maintenance difficulties.

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Recommendations: (1) Perform daily jar testing at the plant. (2) Clean the chlorine contact chamber. (3) Substitute EPA method 604 for EPA method 423 in determining effluent phenol concentration, if possible. (4) Repair the gaps between the clarifier walls and the overflow weirs. (5) Increase the trickling filter recirculation during periods of low influent flow. (6) Consider construction of an aerated wastewater equalization basin.

ACKNOWLEDGMENTS

The author would like to express his appreciation for the support of Capt Christopher Sherman, 2Lt Charles Attebery, 2Lt Michael Spakowicz, Consultants, and MSgt Horace Burbage, SSgt Mary Fields, SrA Robert P. Davis, Technicians, USAFOEHL/ECQ, in accomplishing this survey. The support of the McGuire AFB Bioenvironmental and Civil Engineering Sections was greatly appreciated as well.

CONTENTS

I. INTRODUCTION

On 25 Mar 86, HQ MAC/SGPB requested the USAF Occupational and Environmental Health Laboratory (USAFOEHL) evaluate the McGuire AFB Wastewater Treatment Plant. A proposed Fort Dix/McGuire combined Sewage Treatment Plant was delayed until FY 1991; thus, an evaluation survey was requested to determine whether changes in plant operation could enhance the ability of McGuire AFB Wastewater Treatment Plant personnel to meet NJPDES effluent compliance agreements in the interim. The survey was conducted at McGuire AFB from 3 to 17 November 1986 by the following members of the USAFOEHL Consultant Services Division, Environmental Quality Branch: Capt Christopher P.C. Sherman, 1Lt Francis E. Slavich, 2Lt Charles Attebery, 2Lt Michael Spakowicz, MSgt Horace Burbage, SSgt Mary Fields, and SrA Robert P. Davis.

The objectives of the survey were to evaluate the: (1) individual treatment plant unit processes; (2) influent and effluent sewage quality; (3) treatment plant flow rates; and (4) operation and maintenance practices. Recommendations to insure compliance with discharge requirements were requested.

II. BACKGROUND

A. Introduction

McGuire AFB (MAFB) is situated in a semirural area of the northeastern section of Burlington County three miles southeast of neighboring Ocean County in southern New Jersey. Approximately 85 percent of the surrounding land areas are dominated by farms, vacant land, and wooded country. The base has a total area of 3490.82 acres on a plateau with gently rolling hills. The effective population of the base is 11,700 which includes military, dependents, and civilians.

The climate of MAFB is a continental, temperate climate with cold winters and hot humid summers. The mean temperature range is 43-87°F with winter temperatures of 5°F and summer temperatures of 100°F. Average annual precipitation is approximately 44 inches distributed fairly evenly during the year.

B. Facility Description

1. Treatment Plant - General

a. The MAFB treatment plant is located in the southeastern corner of the base. The plant has a design capacity of 1.25 million gallons per day (MGD). Secondary treatment is attained by using two trickling filters. Wastewater treatment consists of screening and grit removal, primary clarifiers, high rate trickling filters, secondary clarifiers, and chlorine contact tanks. The effluent is discharged to South Run, a small off-base stream. The volume of solids are reduced in anaerobic digestors, and the sludge is then hauled to the Mt. Holly Sewerage Authority for disposal, approximately 15 miles away.

b. The wastewater enters the plant from the sewer system and proceeds through a mechanical bar screen, through an aerated grit chamber, and into the primary clarifiers where the primary solids are settled. After the primary clarifiers, the effluent flow proceeds into the high rate trickling filters for biological treatment. The effluent then enters the secondary clarifiers for secondary settling and proceeds to the chlorine contact chamber. Chlorine is applied and the effluent is discharged to South Run, an off-base creek.

2. Treatment Plant Unit Operations

a. Primary Clarifier - The primary clarifier has a surface area of 3,470 square feet (sq ft) and a design volume of approximately 35,400 cubic feet (cu ft) or 265,000 gallons based on an average flow of 1.25 million gallons per day (MGD) and a detention time of 5 hours (hrs). The effluent flows over the weir and proceeds to the high rate trickling filters. From the clarifier, sludge and scum are pumped to the anaerobic digestor No. 1.

b. Trickling Filters - The plant has two high rate trickling filters having a total area of 0.230 acres (10,019 sq ft) and a total volume of stone of 0.692 acre feet (30,144 cu ft). The recirculation rate is 1.25 MGD (a one to one ratio with the plant influent design flow) to give a total flow through the trickling filters of 2.50 MGD. From the trickling filters the flow enters the secondary clarifier.

c. Secondary Clarifier - The secondary clarifier has a surface area of 3,470 sq ft and a design volume of 35,400 cu ft or 265,000 gallons based on an average flow of 2.5 MGD and retention time of 2.5 hours. The effluent flows over a weir and into the chlorine contact chamber. From the clarifier, sludge is pumped to the anaerobic digestor No.1.

d. Anaerobic Digestor - The two 20,000 cu ft anaerobic digestors are operated in series with digestor No. 1 receiving the sludge from both the primary and secondary clarifiers. The basis for the design of the digestor is an average detention time of 16 days, a daily sludge production of 100 cu ft per 1,000 persons, and an average population of 12,500. The digested sludge is then hauled to Mt. Holly Sewerage Authority, located approximately 16 miles away.

e. Chlorine Contact Chamber - The discharge from the secondary clarifier flows through the chlorine contact chamber, the chamber has a detention time of 24 minutes, based on the design flow of 1.25 MGD. Effluent is then discharged into South Run, a tributary of Crosswicks Creek, eventually flowing to the Delaware River.

C. Wastewater Discharge Requirement

The New Jersey Pollutant Discharge Elimination System limitations permit for McGuire AFB was issued on 15 Aug 1977 and was to expire on 30 Jun 1982; however, the permit expiration date has been extended and the permit has been modified pending completion of the Facility Planning Document for the proposed Fort Dix-McGuire AFB Wastewater Treatment Plant. The modifications to the original discharge permit became effective on 12 Jun 1985. Table 1 lists the parameters and limitations currently in effect.

TABLE 1

SCHEDULE OF DISCHARGE LIMITS FOR MCGUIRE AFB

Interim Limits:

Pollutant	30 Day Avg	7 Day Avg	Required %Removal
BOD5	30 mg/1	45 mg/1	68
Suspended Solids	30 mg/1	45 mg/1	74
Oil and Grease	10 mg/1	15 mg/1	N/A
Phosphorus *	5 mg/1	8 mg/1	N/A
Ammonia as N	11 mg/1	14 mg/1	N/A
Phenols	10 µg/1	20 ug/1	N/A
MBAS	3 mg/1	4 mg/1	N/A
Fecal Coliforms	200/100 ml (Geometric Avg)		

* Note: May be revised depending on results of chemical additions for Phosphorus removal.

III. PROCEDURES

A. Flow

Influent flow data for the seven day sampling period were collected by utilizing the Wastewater Treatment Plant's flowmeter and 12 inch Parshall Flume. Flow values recorded from the flowmeter's totalizer were verified against the flowmeter's strip chart values.

B. Sampling

1. Sampling site numbers and locations.

A list of sampling site numbers and locations where the samples were taken is shown in Table 2.

TABLE 2

SAMPLE SITE LOCATIONS

No.	Sample Site Locations
1	Wastewater Treatment Plant (WTP) Influent
2	WTP Effluent
3	Primary Clarifier Effluent
4	Trickling Filter 1 Effluent
5	Trickling Filter 2 Effluent
6	Secondary Clarifier Effluent
7	Raw Sludge Return Sump
8	Secondary Anaerobic Digestor

2. Sampling Frequency

Daily collection of hourly, equally proportioned, composited samples was accomplished at sites 1-6 for seven days. Daily grab samples were collected for seven days from sites 7 and 8. Also, grab samples for volatile organics were collected on 2 days at sites 1, 2, and 6. Equipment used for the composite sampling was the ISCO Automatic Wastewater Composite samplers, Models 2100 and 1580. Samples were analyzed for the parameters listed in Table 3.

TABLE 3

SAMPLE ANALYSIS AND PRESERVATION METHODS

Analysis	Applicable Sites	Method	Where	Who
BOD5	1-6	A405.1	on-site	USAFOEHL
COD	1-6	Hach Mod.	on-site	USAFOEHL
Nonfilterable Residue	1-7	A160.2	on-site	USAFOEHL
Filterable Residue	1-7	A160.1	on-site	USAFOEHL
Fecal Coliform	1,2	A909C	on-site	USAFOEHL
Oil and Grease	1,2,8	E413	off-site	USAFOEHL
Phenols	1,2,8	E604	off-site	USAFOEHL

TABLE 3 Continued

Analysis	Applicable Sites	Method	Where	Who
MBAS	1,2	E425.1	off-site	USAFOEHL
Ammonia	1,2,8	E350.1	off-site	USAFOEHL
Total Kjeldahl Nitrogen	1,2,8	E351.2	off-site	USAFOEHL
Nitrates-Nitrites	1,2,8	E353.2	off-site	USAFOEHL
Phosphorus	1,2,8	E365.4	off-site	USAFOEHL
Potassium	1,2,8	E258.1	off-site	USAFOEHL
Cyanide	1,2,8	E335.3	off-site	USAFOEHL
Mercury	1,2,8	E245.1	off-site	USAFOEHL
Hexavalent Chromium	1,2,8	E218.4	off-site	USAFOEHL
Metals Screen B, Cd, Cr, Cu, Zn, Pb, Ni, Se, Mn, Ag	1,2,8	E200.7	off-site	USAFOEHL
Sulfate	1,2,8	E375.2	off-site	USAFOEHL
Sulfides	1,2,8	E376.2	off-site	USAFOEHL
Volatile Halocarbons	1,2,6	E601	off-site	USAFOEHL
Volatile Aromatics	1,2,6	E602	off-site	USAFOEHL

Notes: A = APHA, "Standard Methods for the Examination of Water and Wastewater", 16th Ed.

E = USEPA, "Methods for Chemical Analysis of Water and Wastes"

USAFOEHL personnel performed BOD5, total suspended solids, total dissolved solids, volatile suspended solids, COD, and fecal coliform analyses on-site. Other chemical analyses were performed by the USAFOEHL, Analytical Services Division, Brooks AFB TX. These included: oils and grease, nutrients (nitrite, nitrate, total kjeldahl nitrogen, and phosphorus), phenols, metals, sulfates and sulfides, and volatile halocarbons and aromatic organic compounds. Unit processes were evaluated mainly from BOD5 and total suspended solids results as discharge design criteria is available for these parameters. All analyses were performed in accordance with Standard Methods

for the Examination of Water and Wastewater, 16th Ed., 1984 and USEPA approved analytical methods.

IV. RESULTS AND DISCUSSION

A. Wastewater Treatment Plant Hydraulics

1. WTP Flow Measurements:

The flow data for the seven-day sampling period are shown in Table 4. The average flow was 1.13 MGD. This value corresponds closely to the average flow design capacity of 1.25 MGD. The plant was designed for peak flows to 3.75 MGD. This level was not exceeded during the survey period. Influent flows during the late night and early morning hours appear to be insufficient to turn the trickling filter distributor arms. USAFOEHL personnel observed the arms had completely stopped on several occasions between the hours of 0700 and 0800.

TABLE 4

WTP FLOW DATA

Date	Flow (gpd)	
6 Nov 86	1,182,100	
7 Nov 86	1,183,800	
8 Nov 86	1,032,800	
9 Nov 86	1,129,900	
10 Nov 86	1,032,200	
11 Nov 86	1,209,400	
12 Nov 86	1,128,400	
	1,128,371	(7-day Avg.)

2. Recirculation:

Recirculation flow from the secondary clarifier overflow is pumped to the head of the trickling filters via a 900 gpm pump operating 24 hours a day. The recirculated flow is 1.25 MGD; therefore, the WTP recirculation ratio is approximately 1 to 1.

3. Clarifier Overflow Rates:

The surface overflow rate for the primary clarifiers was found by dividing the daily average flow by the clarifier surface area. This calculation resulted in a 325 gpd/sq ft overflow rate, which is less than the design value of 360 gpd/sq ft. The surface overflow rate for the secondary

clarifiers including recirculation was 686 gpd/sq ft. Again, this value is less than the design figure of 720 gpd/sq ft.

4. Organic Loading:

The organic loading rate to the trickling filters, calculated by multiplying the average recirculated BOD5 by the total flow, was 1200 lbs/day. This value is below the design value of 1626 lbs/day.

B. Wastewater Treatment Plant Efficiency

1. Biochemical Oxygen Demand (BOD5) Removal:

Results for BOD5 are shown in Appendix A. Influent values range from 97 mg/1 to 169 mg/1, with an average of 135 mg/1. Effluent values ranged from 17.5 mg/1 to 59 mg/1, with an average of 39.6 mg/1. This produced a removal efficiency of approximately 71%, which is very close to the compliance standard of 68%. Glutamic acid check samples were within the acceptable range stated in "Standard Methods for the Examination of Water and Wastewater".

It should be noted that the average BOD5 increased by 49% from the secondary clarifier effluent to the plant effluent. USAFOEHL personnel observed significant amounts of scum and other organic matter floating in the chlorine contact chamber which could easily account for the BOD5 increase. Ideally there should be no significant increase in BOD5 after the wastewater leaves the secondary clarifier. Utilizing the average BOD5 value for the secondary clarifier effluent gives a removal efficiency of approximately 81% and a final BOD5 value of 26.5 mg/1. Both of these results are well within NJPDES limits.

2. Total Suspended Solids (TSS) Removal:

TSS results are shown in Appendix B. Influent values ranged from 99 mg/l to 568 mg/l, with an average of 278 mg/l. Effluent values ranged from 6.0 mg/l to 403 mg/l, with an average of 121 mg/l; thus, the removal efficiency was approximately 56%. the NJPDES limits for these parameters are 45 mg/l as a 7-day average for TSS and 74% removal, respectively. Again, there was a sizeable increase in the concentration (almost 10%) from the secondary clarifier effluent to the final effluent, probably due to floating organic matter in the chlorine contact chamber.

The 7-day removal efficiency found during this survey is consistent with historical data for calendar years 1984 and 1985. This fact notwithstanding, USAFOEHL personnel frequently observed reddish colored solids flowing over the primary sedimentation tank weirs, which could suggest that the WTP's coagulant dosage was incorrect during the survey period and thus contributed to the poor suspended solids removal. Also, gaps between the secondary clarifier walls and the weirs promoted short-circuiting, allowing solids to pass through.

3. Volatile Suspended Solids (VSS) Removal:

VSS results are shown in Appendix C. Influent values ranged from 75 mg/l to 252 mg/l, with an average of 121 mg/l. Effluent values ranged from 9.0 mg/l to 45 mg/l, with an average of 28 mg/l. VSS removal efficiency averaged 77%.

4. Total Dissolved Solids (TDS) Removal:

TDS results are shown in Appendix D. Influent results ranged from 65 mg/l to 676 mg/l, with an average of 248 mg/l. Effluent values ranged from 15 mg/l to 638 mg/l, with an average of 273 mg/l; thus, there was an overall increase in TDS results from influent to effluent. This is probably due to ferric chloride addition.

5. Chemical Oxygen Demand (COD) Removal:

Results for COD are shown in Appendix E. Influent values ranged from 155 mg/l to 400 mg/l, with an average of 272 mg/l. Effluent values ranged from 30 mg/l to 75 mg/l, with an average of 67 mg/l. This gave a removal efficiency of 74%. As with BOD5 and TSS, there was a significant increase in concentration between the secondary clarifier effluent and the final effluent (approximately 20%).

C. Wastewater Characterization

1. Influent BOD5 to COD Ratio:

The BOD5 to COD ratio ranged from 0.404 to 0.87, with an average of 0.59. Ratio results greater than 0.50 are considered to be indicative of domestic wastewater amenable to biological treatment; while those less than 0.50 indicate wastewater of industrial origin.

2. Fecal Coliforms:

Results for fecal coliforms are shown in Appendix F. Influent values ranged from 270,000 colonies/100 ml to 810,000 colonies/100 ml, with an average of 541,667 colonies/100 ml. No colonies were found in the effluent for the entire sampling period. All pre and post control samples for the seven day period were also negative.

3. Oil and Grease:

Sampling results for this parameter are shown in Appendix G. Influent values ranged from 19 mg/l to 29 mg/l, with an average of 24 mg/l. Effluent values ranged from 6.9 mg/l to 2.1 mg/l, with an average of 3.5 mg/l. This result is well below the 7-day NJPDES effluent standard of 15 mg/l.

4. Ammonia:

Sampling results for ammonia are shown in Appendix G. Influent values ranged from 14 mg/l to 21 mg/l, with an average of approximately 17 mg/l. Effluent values ranged from 7.5 mg/l to 13 mg/l, with an average of 10 mg/l. The 7-day NJPDES limit for ammonia is 14 mg/l.

5. Phosphorus:

Sampling results for phosphorus are shown in Appendix G. Influent values ranged from 3.2 mg/l to 4.9 mg/l, with an average of 4.2 mg/l. Effluent values ranged from .65 mg/l to 1.3 mg/l, with an average of 1.1 mg/l. This value is well below the 7-day NJPDES limit of 8 mg/l.

6. Phenols:

Results for phenols are shown in Appendix G. Influent values ranged from 10 µg/l to 40 µg/l, with an average of 21.4 µg/l. Effluent values ranged from 10 µg/l to 200 µg/l, with an average of 67 µg/l. This value is above the 7-day NJPDES standard of 20 µg/l. The average concentration in the anaerobic digestor was 174 µg/l. The increase in concentration seen between influent and effluent could be due to the leaching of phenols from the sludge in the anaerobic digestor, which are then reintroduced to the plant via the supernatant return line.

7. Methylene Blue Active Substances (MBAS):

Results for MBAS are shown in Appendix G. Influent values ranged from .10 mg/l to .30 mg/l, with an average of .17 mg/l. Effluent values ranged from 1.7 mg/l to 2.0 mg/l, with an average of 1.8 mg/l. This value is below the 7-day NJPDES standard of 4 mg/l. The increase in MBAS seen from the influent to the effluent could be an analytical anomaly or a result of WTP personnel rinsing wash water into the plant during routine cleaning.

8. Heavy Metals:

Sampling results for heavy metal are shown in Appendix G. Cadmium, chromium, hexavalent chromium, lead, mercury, nickel, selenium, and silver, were not detected at the influent or effluent; however, cadmium, nickel, and silver, were detected in anaerobic digestor in small amounts. Copper and zinc were detected at the influent in concentrations less than 100 µg/l, but were not detected at the effluent.

Influent results for manganese ranged from 68 µg/l to 249 µg/l, with an average of 145 µg/l. Effluent values ranged from 80 µg/l to 128 µg/l, with an average of 109 µg/l. The average value in the anaerobic digestor was 3.3 mg/l.

Influent results for potassium ranged from 7.2 mg/l to 9.3 mg/l, with an average of 8.3 mg/l. Effluent values ranged from 9.0 mg/l to 10.0 mg/l, with an average of 9.5 mg/l. The average value in the anaerobic digestor was 33.3 mg/l. Neither potassium or manganese have been found to be inhibitory to aerobic or anaerobic processes at the above reported values.

Influent values for boron averaged 550 µg/l, while effluent values averaged 538 µg/l. The average value in the anaerobic digestor was 779 µg/l. Concentrations of boron ranging from .05 mg/l to 100 mg/l have been found to be inhibitory to aerobic processes; thus, influent values at the McGuire WTP could be adversely affecting the treatment process. The threshold concentration for anaerobic inhibition has been reported as 2.0 mg/l, which is well above the concentrations found during this survey.

9. Volatile Organics:

Detectable results for volatile aromatics and halocarbons are shown in Appendix H. Small amounts of methylene chloride and 1,4 dichlorobenzene were found at all three sites. Toluene was detected at the influent and effluent, but not at the effluent to the secondary clarifier. Increased concentrations of dichlorobenzenes seen at the effluent could be due to the reaction of chlorine with toluene. The chloroform found at the effluent is probably the reaction product of chlorine and organic precursors. The largest concentration of volatile organics found in the WTP effluent was 19.9 µg/l of methylene chloride; while the largest concentration found at the WTP influent was 29 µg/l of toluene.

V. OBSERVATIONS AND CONCLUSIONS

A. Sewage Treatment Plant Unit Processes

The unit processes at the McGuire AFB Wastewater Treatment Plant appear to be performing adequately; notwithstanding correctable minor operation and maintenance deficiencies. The plant is presently exceeding the 7-day NJPDES effluent standards for Total Suspended Solids, Removal efficiency for TSS, and Total Phenols. In addition, the 7-day removal efficiency standard for BOD5 is close to non-compliance. During the survey period the plant was not overloaded, either hydraulically or organically.

Problems with TSS, BOD5, and COD removal appear to be caused by several factors, primary among them being the condition of the chlorine contact chamber. Floating scum and sludge cakes rising from the bottom of the tank are certainly contributing to increasing the values in the final effluent. In addition, short circuiting in the secondary clarifier is allowing significant amounts of organic matter to pass over the weirs. Also, during the survey period WTP personnel were using a trial and error method to determine the optimal dose for their anionic polymer, and ferric chloride coagulants. It appeared that this approach was responsible for the reddish-colored scum observed floating in the primary clarifier, and subsequently flowing through the plant. Finally, the trickling filter, distributor arms failure to rotate during periods of low flow is preventing even distribution of wastewater on the filter media. This results in biomass dessication, and thus decreased filter performance.

Total phenol concentrations have varied widely. During this survey the influent value averaged a relatively low 21 µg/l. The average effluent concentration increased significantly to 67 µg/l. It is possible that interferences from phenoxy-based surfactants in aircraft cleaning compounds are producing erroneously high results. In addition, phenols may be recycling via the supernatant return line from the secondary anaerobic digestor.

B. Wastewater Constituents

Wastewater entering the McGuire AFB Wastewater Treatment Plant is primarily domestic in nature. Boron was the only metal detected at concentrations which could possibly inhibit aerobic processes; while none of the metals detected in the secondary digestor approached inhibitory levels.

Six volatile organics were detected at either the WTP influent, secondary clarifier effluent, or the final effluent at relatively low concentrations. These substances were; methylene chloride, toluene, chloroform, 1,2 dichlorobenzene, 1,3 dichlorobenzene, and 1,4 dichlorobenzene. Methylene chloride is a waste product of paint stripping operations. Toluene is used in solvent cleaners and painting operations. Chloroform is a reaction product of chlorine and organic percursors; and dichlorobenzenes are ingredients of carbon removers.

VI. RECOMMENDATIONS

1. McGuire AFB Wastewater Treatment Plant personnel should acquire the capability to perform daily jar testing in order to determine the optimum dose for their ferric chloride and polymer coagulants. (procedure attached in Appendix I)

2. The chlorine contact chamber should be cleaned on a regular basis by removing accumulated sludge and floating scum.

3. Substitute EPA Method 604 for EPA 423 in determining effluent phenol concentration, unless the NJPDES permit requires Method 423. EPA Method 604 is specific for individual phenolic compounds and the net result is not interfered with phenoxy-based surfactants. The results of the specific phenolic compounds from EPA Method 604 would then be added up to give a Total Phenol Concentration.

4. McGuire AFB Wastewater Treatment Plant personnel should repair the gaps between the clarifier walls and the overflow weirs to prevent short-circuiting.

5. Increase the trickling filter recirculation during periods of low influent flow to prevent the filter distributor arms from stopping. This will insure a more even distribution of nutrients to the filter media. Total flow, including recirculation, should not exceed the secondary clarifier overflow rate of 725 gpm/sq ft.

6. Consider the constuction of an aerated wastewater equalization basin at the STP influent. This would serve to:

a. Thoroughly mix the influent wastewater to prevent a concentrated slug of toxic materials from entering the plant and inhibiting the biological processes.

b. Minimize the hydraulic and organic loading problems associated with widely varying diurnal flow patterns.

c. Reduce influent phenol concentrations.

d. Allow for a more effective application of coagulants from a better mixing of the wastewater.

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APPENDIX A

Biochemical Oxygen Demand (BOD5)

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BIOCHEMICAL OXYGEN DEMAND (BOD5) RESULTS IN mg/l FOR MCGUIRE AFB WASTEWATER TREATMENT PLANT EVALUATION SURVEY

Date	Site Numbers #1	#2	#3	#4	#5	#6
6 Nov	115.6	46.8	113	NR	NR	12.0
7 Nov	169.4	20.5	142.3	46.2	47.7	31.8
8 Nov	158.4	59.0	92.2	42.5	51.7	46.7
9 Nov	135	32.3	59.9	22.5	23.2	26.7
10 Nov	96.9	39.5	81.0	18.0	19.4	15.4
11 Nov	NR	17.5	92	27.5	21.5	13.8
12 Nov	NR	NR	NR	NR	NR	NR
Average Conc.	135.1	39.6	97.7	31.3	32.7	26.5

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APPENDIX B

Total Suspended Solids (TSS)

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TOTAL SUSPENDED SOLIDS (TSS) RESULTS IN mg/l FOR MCGUIRE AFB
WASTEWATER TREATMENT EVALUATION SURVEY

Date	Site Number						
	#1	#2	#3	#4	#5	#6	#7
6 Nov	321	225	280	223	230	214	45900
7 Nov	112	45	84	29	36	22	38600
8 Nov	175	59	74	49	53	40	42220
9 Nov	130	59	51	30	17	51	28830
10 Nov	99	49	48	4.0	8.0	13	21700
11 Nov	544	6.0	91	31	28	17	36550
12 Nov	568	403	499	416	439	417	24860
Average Conc.	278	121	161	112	116	111	34094

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APPENDIX C

Volatile Suspended Solids (VSS)

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VOLATILE SUSPENDED SOLIDS (VSS) RESULTS IN mg/l FOR MCGUIRE AFB WASTEWATER TREATMENT PLANT EVALUATION SURVEY

Date	Site Numbers						
	#1	#2	#3	#4	#5	#6	#7
6 Nov	108	28	48	38	21	25	18400
7 Nov	88	36	67	24	29	17	31000
8 Nov	75	9.0	26	7.0	23	31	24270
9 Nov	104	45	41	24	13	40	22210
10 Nov	86	26	36	32	34	26	14340
11 Nov	137	18	77	26	21	15	24280
12 Nov	252	32	103	56	16	28	14200
Average Conc.	121.4	27.7	60.9	30.1	22.1	27	21243

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APPENDIX D

Total Dissolved Solids (TDS)

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TOTAL DISSOLVED SOLIDS (TDS) RESULTS IN mg/l FOR MCGUIRE AFB WASTEWATER TREATMENT PLANT EVALUATION SURVEY

Date	Site Numbers	
	#1	#2
6 Nov	65	166
7 Nov	176	15
8 Nov	240	388
9 Nov	100	162
10 Nov	98	147
11 Nov	676	638
12 Nov	378	393
Average Conc.	247.6	273

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APPENDIX E

Chemical Oxygen Demand (COD)

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CHEMICAL OXYGEN DEMAND (COD) RESULTS IN mg/l FOR MCGUIRE AFB WASTEWATER TREATMENT PLANT EVALUATION SURVEY

Date	Site Numbers #1	#2	#3	#4	#5	#6
6 Nov	280	30	220	22	55	25
7 Nov	220	68	235	81	86	65
8 Nov	320	75	240	70	50	60
9 Nov	155	55	125	50	33	46
10 Nov	240	45	230	80	72	48
11 Nov	400	60	265	100	80	100
12 Nov	290	60	310	90	60	50
Average Conc.	272	67.6	232	70.4	62.3	56.3

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APPENDIX F

Fecal Coliforms

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FECAL COLIFORM RESULTS FOR MCGUIRE AFB WASTEWATER TREATMENT PLANT EVALUATION SURVEY

Date	Site Numbers #1	Site Numbers #2
6 Nov	810000 colonies/100ml	0.0 colonies/100ml
7 Nov	NG (No Growth)	
8 Nov	530000 colonies/100ml	0.0 colonies/100ml
9 Nov	500000 colonies/100ml	0.0 colonies/100ml
10 Nov	750000 colonies/100ml	0.0 colonies/100 ml
11 Nov	390000 colonies/100ml	0.0 colonies/100ml
12 Nov	270000 colonies/100ml	0.0 colonies/100ml
Average # of colonies	541667 colonies/100ml	0.0 colonies/100ml

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APPENDIX G

Oil and Grease, Ammonia, Phosphorus,

Phenols, MBAS, and Heavy Metals

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OIL AND GREASE, AMMONIA, NUTRIENTS, PHENOLS, MBAS, AND HEAVY METALS RESULTS FOR THE MCGUIRE AFB WASTEWATER TREATMENT PLANT EVALUATION SURVEY

Parameter	Site	#Samples	#Detected	High	Low	Avg.
Oil/Grease	Influent	7	7	29 mg/l	19	24.1
	Effluent	7	7	6.9	2.1	3.5
	Digestor	7	7	6180	360	2526
Ammonia	Influent	7	7	21 mg/l	14.4	16.6
	Effluent	7	7	13.2	7.6	10.1
	Digestor	7	7	460	80	320
Nitrate	Influent	7	0	N/A	N/A	<.10
	Effluent	7	6	1.5 mg/l	1.2	1.40
	Digestor	7	1	54	54	N/A
Nitrite	Influent	7	0	N/A	N/A	<.02
	Effluent	7	0	N/A	N/A	<.02
	Digestor	7	5	2.0 mg/l	2.0	2.0
TKN	Influent	7	7	98 mg/l	18.6	56.7
	Effluent	7	7	20	11	14.3
	Digestor	7	7	460	92	379
Phosphorus	Influent	7	7	4.9 mg/l	3.2	4.2
	Effluent	7	7	1.3	.65	1.1
	Digestor	7	7	10.5	4.8	7.0
Cyanide	Influent	7	0	N/A	N/A	<.01
	Effluent	7	0	N/A	N/A	<.01
	Digestor	7	7	.08 mg/l	.04	.058
Phenols	Influent	7	5	40 ug/l	10	21.4
	Effluent	7	4	200	10	67
	Digestor	7	6	560	10	174
Cadmium	Influent	7	0	N/A	N/A	<10
	Effluent	7	0	N/A	N/A	<10
	Digestor	7	5	19 ug/l	14	17.2
Chromium	Influent	7	0	N/A	N/A	<50
	Effluent	7	0	N/A	N/A	<50
	Chromium	7	0	N/A	N/A	<50
Chromium +6	Influent	7	0	N/A	N/A	<50
	Effluent	7	0	N/A	N/A	<50
	Digestor	7	0	N/A	N/A	<50
Copper	Influent	7	6	79 ug/l	35	49
	Effluent	7	0	N/A	N/A	<20
	Digestor	7	7	55	31	44.[illegible]

Lead	Influent	7	0	N/A	N/A	<20
	Effluent	7	1	127 ug/l	127	N/A
	Digestor	7	0	N/A	N/A	<20
Manganese	Influent	7	7	249 ug/l	68	145
	Effluent	7	6	128	80	109
	Digestor	7	7	5330	585	3273
Mercury	Influent	7	0	N/A	N/A	<1.0
	Effluent	7	0	N/A	N/A	<1.0
	Digestor	7	0	N/A	N/A	<1.0
Nickel	Influent	7	0	N/A	N/A	<50
	Effluent	7	0	N/A	N/A	<50
	Nickel	7	7	231 ug/l	105	179
Selenium	Influent	7	0	N/A	N/A	<10
	Effluent	7	0	N/A	N/A	<10
	Digestor	7	0	N/A	N/A	<10
Silver	Influent	7	0	N/A	N/A	<10
	Effluent	7	0	N/A	N/A	<10
	Digestor	7	4	21 ug/l	10	15.2
Zinc	Influent	7	3	134 ug/l	66	91
	Effluent	7	0	N/A	N/A	<50
	Digestor	7	7	348	73	183
Potassium	Influent	7	7	9.3 mg/l	7.2	8.3
	Effluent	7	7	10.0	9.0	9.5
	Digestor	7	7	36.6	31.7	33.3
Boron	Influent	7	2	550 ug/l	550	550
	Effluent	7	4	600	500	538
	Digestor	7	7	950	500	779
Sulfate	Influent	7	7	20 mg/l	13	16.4
	Effluent	7	7	26	23	25.3
MBAS	Influent	7	7	.30 mg/l	.10	.17
	Effluent	7	7	2.0	1.7	1.8
Sulfides	Influent	7	1	.30 ug/g	.30	N/A
	Effluent	7	0	N/A	N/A	<.02

APPENDIX H

Volatile Aromatics and Halocarbons

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DETECTABLE AMOUNTS OF VOLATILE AROMATICS AND HYDROCARBONS

Site	Substance	Concentration (ug/l)
#1 (influent)	Methylene chloride	4.9, 2.8
	Toluene	28, 3.0
	1,4 dichlorobenzene	TR, TR
#2 (secondary clarifier)	Methylene chloride	22.1, 9.3
	1,3 dichlorobenzene	3.6
	1,4 dichlorobenzene	3.1
#6 (effluent)	Methylene chloride	19.9, 9.4
	Chloroform	9.9, 9.5
	1,2 dichlorobenzene	6.6, 6.0
	1,3 dichlorobenzene	9.0, 4.5
	1,4 dichlorobenzene	4.1, TR
	Toluene	2.3, TR

Note: TR means the substance was detected in trace amounts i.e. not enough to quantify

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APPENDIX I

Procedure for Jar Testing

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JAR TESTING PROCEDURE

Equipment Needed: 1 Phipps Bird Apparatus
1 Turbidity Meter
1 pH Meter
6 Glass Containers (at least 1.5 liter)

Method:

1. Fill six jars from a large container (>5 gal) with 1000 ml of untreated, raw wastewater.

2. Pick one jar as the control, and record the initial pH, temperature, and turbidity.

3. Select a range of five coagulant concentrations to be added to the remaining containers. For ferric chloride, a typical range might be: 10 mg/l, 25 mg/l, 40 mg/l, 55 mg/l, and 70 mg/l. Polymers typically range from 0.10 to 5.0 mg/l.

4. Add the coagulants to the 1000 ml volumes and rapid mix at 40 rpm for 10 minutes. (Note: record the concentration added to each container)

5. Slow the apparatus to 13 rpm for 15 minutes to form floc.

6. Turn the stirrers off and allow the floc to settle for 15 minutes.

7. Extract a 25 ml sample from the supernatant of each container, being careful not to disturb the settled floc.

8. Measure and record the final temperature, pH, and turbidity from the five supernatant samples.

9. Calculate the percentage of turbidity removed for each container:
%turbidity removed = 100 (1 - final turbidity/initial turbidity)

10. Compare the removal efficiencies to select the most effective coagulant dose.

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Distribution List

	Copies
HQ AFSC/SGPB Andrews, AFB DC 20334-5000	1
HQ USAF/SGPA Bolling AFB DC 20332-6188	1
AAMRL/TH Wright-Patterson AFB OH 45433-6573	1
HQ MAC/SGPB Scott AFB IL 62221-5300	1
HQ MAC/DE Scott AFB IL 62221-5001	1
USAF Regional Medical Center Wiesbaden/SGB APO New York 09220-5300	1
OL AD, USAFOEHL APO San Francisco 96274-5000	1
USAFSAM/TSK Brooks AFB TX 78235-5301	1
Defense Technical Information Center (DTIC) Cameron Station Alexandria VA 22319	2
HQ USAF/LEEV Bolling AFB DC 20330-5000	1
HQ AFESC/RDV Tyndall AFB FL 32404-6001	1
USAF Clinic McGuire/SGPB McGuire AFB NJ 08641-5300	3
438 ABG/DEEV McGuire AFB NJ 08641-500	3

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